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EXECUTIVE SUMMARY

THE CHARACTERIZATION OF NON PROCESSABLE LOW LEVEL RADIOACTIVE WASTE

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Determination of the physical, chemical and radiochemical composition of low and intermediate level waste is the necessary first step in assessing radioactive waste management options. Chemical Research with funding from NMMD has been systematically characterizing radioactive waste generated as a result of operation and maintenance of the Nuclear Generating Stations.

It has been estimated that about 1000 m^3 of non processable waste is generated annually with this figure increasing to 1500 m^3 per year when Darlington goes on line. Even though the waste processing facilities at BNPD are unable to treat this particular waste stream at present, technology is available to reduce the volume of this waste stream significantly. The purpose of the work presented in this report was to determine the composition of the waste stream and thereby assess whether advanced processing technology can be cost effectively applied to this waste.

The waste bags are contained in 3.7 m^3 rectangular containers which when full are stored in the Low Level Storage Building. The waste in the bags is highly heterogenous, has a mean density of 227 kg/m^3 and has a mean composition of 33% metal, 25% non combustible absorbent such as floor sweeping compound, sand and vermiculite, 16% paper, 8% plastic, 5% wood, 6% concrete debris, 3% paper, 3% rubber and 1% glass. The contact dose associated with these waste containers was consistently less than 25 mR/h and consequently would not make further processing too complicated. The radioactivity of the waste (3 mCi/m^3) is predominantly due to Co-60 and Cs-137. The waste contained a significant volume (3%) of dry cleaning filters which could be easily volume reduced either by replacing the metallic components of the filters or the use of the existing compactor/baler.

job	file	date	report no.
32-203-462	837.812	March 15, 1988	88-33-K

The data shows that not only is the waste inefficiently packaged as the low density indicates, but the waste contains a significant volume of processable material. The best volume reduction of this waste could be achievable by a combination of better segregation and high force compaction. However increased handling of the waste may not only be impractical but could be in conflict with ALARA concepts which require the adoption of techniques and procedures which reduce occupational dose.

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THE CHARACTERIZATION OF NONPROCESSABLE LOW LEVEL RADIOACTIVE WASTE

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The physical and radiochemical composition of Type I (<200mR/h) non processable radioactive waste has been determined primarily to assess the suitability of new volume reduction technology to this waste stream. The waste is highly heterogenous and contains processable components. Furthermore, the mean density of the storage containers is 227 kg/m^3 which is considerably lower than the theoretical density of the waste materials suggesting that more efficient packaging is possible. The radiation fields associated with this waste stream are low <25mR/h) due primarily to Co-60 and Cs-137. Further processing should take into consideration the increase in occupational dose levels.

1.0 INTRODUCTION

Research Division has over the last three years undertaken, under NMMD sponsorship, a program to characterize low and intermediate level radioactive waste streams arising from routine reactor operations as well as large scale maintenance activities. To date, the following waste streams have been or are in the process of being characterized:

(a) Radioactive incinerator ash/1/.
(b) Compactable Reactor Waste/2/.
(c) Low level waste from the Pickering Large Scale Fuel Channel Replacement Program/3/.
(d) Incinerable reactor waste/4/.
(e) Spent heat transport and moderator ion exchange resins/5/.

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32-203-462	837.812	March 15, 1988	88-33-K

The objectives of Ontario Hydro's waste characterization program are twofold:

(1) To determine the quantity, type, distribution and speciation of radioactivity in the waste in order to:

- improve waste segregation
- develop decontamination strategies
- develop source terms for disposal facility designs and safety assessments.

(2) To determine the physical and chemical composition of the waste in order to:

- improve the effectiveness of existing waste treatment facilities,
- provide data for the design of new volume reduction facilities,
- develop solidification techniques for radioactive liquids.

This report details the characterization of Type I non processable waste (<200 mR/h) arising from routine operations and maintenance activities associated with a 10 GW(e) CANDU nuclear system. The primary goal of this particular project was to provide data to the designers to evaluate new volume reduction technologies such as supercompaction.

2.0 EXPERIMENTAL

Type I non processable waste, packaged in clear polyethylene bags, is stored in the low level storage buildings (LLSB) in 3.7m^3 galvanized steel containers. The characterization of this waste was carried out by removing each bag, weighing it, determining the presence of moisture or other free liquid such as oil, and visually examining the bags to assess the physical composition of the contents. On completion of the visual examination of the bin contents, the contact radiation field at nine locations on each of the four accessible sides of the bin was measured. Subsequently each side of the container was gamma scanned using a portable spectrometer system (Canberra 35 Plus) with the detector positioned 1.6 m away from the sides of the bin to ensure the complete side surface is in the detector field of view. A waste bag of known radiochemical composition was used to calibrate the spectrometer system thus allowing conversion of peak areas to radionuclide activity.

The C-14 activity in this waste stream was not determined because it was assumed to be small compared to non processable waste from the Pickering retubing program/3/. The segregation procedure practised at Pickering identified Unit 1 and 2 non processable waste using blue tape and was apparently effective in view of the absence of blue taped bags in this waste stream.

3.0 DISCUSSION

1114 bags of non-processable waste representing approximately 60 m^3 of storage volume were examined over an 8 month period. This sample represents approximately 6% of the annual generation rate of this particular waste stream/6/. The data for each individual waste bag is available in a LOTUS 1-2-3 spreadsheet format in the Appendix.

Table 1 summarizes the physical composition of the waste bags. A number of assumptions had to be made in order to convert specific items in the bags to a material composition based on volume. It was assumed that:

(a) Electrical cable was 95% by volume metal and 5% by volume plastic insulation.

(b) Dry cleaning filters were 85% paper and 15% by volume metal.

(c) Non combustible absorbents included in Table 1 are floor sweeping compound, sand, vermicullite and low level ion exchange resin.

(d) The glass category in Table 1 includes fluorescent and incandescent light bulbs and fiberglass insulation.

(e) Wood includes activated charcoal absorbent.

(f) The category classified as "other" is mainly concrete debris.

(g) Those bags which could not be lifted out of the containers due to their excessive weight were assigned a weight of 40 kg in the density calculations.

As expected the waste is highly heterogenous. A mean composition calculated from Table 1 shows that the waste is 33% metal, 25% non combustible absorbent, 16% paper, 8% plastic, 6% concrete debris and other sundry materials (leather, batteries), 5% wood 3% each of cotton and rubber and 1% glass. The total weight of the waste bags in each bin divided by the volume of the bin gave an estimate of the waste density of 227 +/- 51 kg/m^3 which is an order of magnitude lower than the theoretical density of the waste as calculated from the mean composition (3360 kg/m^3).

Dry cleaning filters (46 cm long 15 cm diameter) from the Freon dry cleaning facility represented 10% of the total number of waste bags characterized (3% of the total waste volume). It is estimated that approximately 50 filters are generated as waste per week/7/. The waste was characterized over a period of 5 months and over this period 1000 filters or 500 waste bags would have been generated. Based on these numbers, the dry cleaning filter contribution to the non processable waste composition is

considered to be reasonably representative. These filters have a charcoal center core inside a metal perforated sheath, a pleated paper membrane surrounded by a perforated metal membrane support structure. The end plates of this filter have a metal construction. The density of the bags containing these filters was 200 kg/m^3 which suggests that these particular items should be amenable to further processing. This is especially desirable in view of the extensive future use of Freon based dry cleaning facilities at Darlington NGS which will increase the quantities of this particular waste. These filters are easily compacted and according to the filter distributor/8/, a small dedicated compactor is available for these filter cartridges.

In discussion with BNPD personnel/9/, it appears that the possibility of releasing Freon 113 residues from the filters precludes the compaction of these filters using the existing compactor/baler. The paper filter membranes were not visible to determine the degree of filter loading but there was no obvious indication of liquid on the inside of the waste bags. Given the high vapour pressure of Freon 113 (B.P 48^{o}C), it is very likely that the Freon 113 in the filter will evaporate and permeate through the waste bags in time. Storage of the uncompacted filter elements will not prevent the release of Freon to the environment but only reduce the rate of its release. It would be easy enough to measure the residual Freon content in the filters to determine the extent of Freon releases to the environment.

The data showed that 23% of the waste bags examined contained only metallic components while 47% of the bags contained no metal at all. 42% of the bags contained only non-processable materials such as metal, non-combustible absorbent materials, glass and cement. It is also somewhat surprising that 2% of the bags contained nothing but wood which should be easily processable by the radioactive incinerator.

Very few of the waste bags contained any appreciable quantities of free liquid. Some of the bags contained mop heads which were wet and some condensation was apparent on the sides of the bag but this was a small amount of free liquid in a small number of waste bags. Although no attempt was made to determine the tritium content of these waste bags, it is safe to assume that there will be some especially in those bags containing mop heads.

Table 2 summarizes the radionuclide composition data. The maximum radiation field measured on one waste bin was 40 mR/h, but in general the maximum field on most of the bins examined was less than 20mR/h. As mentioned in the experimental section, the radionuclide activities were estimated by calibrating the detector with a bag of known radionuclide activity placed in the center of the waste bin. The detector efficiencies at the various energies measured in this way were then used to convert counts detected per second to activity. This technique must be considered as very approximate because it assumes firstly that

the source is a point source and secondly that the same attenuation factors can be used for each bin. The composition data have shown that the waste is heterogenous and even for those bins which contain essentially similar number of bags of the same composition it is the packing efficiency and the location of the radionuclide sources in the bin which will determine the attenuation factors.

To refine the measuring technique, six bags from each of two bins were removed and individually gamma scanned using a turntable to rotate the bags during spectrum acquisition. The detector efficiencies determined in the retubing waste characterization work were used to measure the activity in the non processable waste bags. This technique more closely approximated a point source. The total radionuclide activity calculated from the six bags was then averaged over the number of bags contained in the bins from which they were removed to obtain the total bin activity. These data are shown in parentheses in the total activity column of Table 2. In one case this method agreed quite well with the bin measurement and in the second case this more accurate method gave a total bin activity a factor of 40 lower than that measured by the less accurate method.

Bearing in mind these shortcomings in the radionuclide composition measurements some generalizations can be made from the data in Table 2.

(a) The maximum activity associated with this waste is 3 mCi/m^3.

(b) Cobalt-60 and cesium-137 together make up over half of the radioactive contents of the bins, with Zr/Nb95 making up 20% of the contents.

(c) There is some tentative evidence for the presence of transuranic activity in at least one bin as indicated by the 59 keV peak assigned to Am-241. The confirmation of this would require more extensive examination of the waste since Am-241 is a weak gamma emitter and is effectively shielded by not only the waste but also by the container.

(d) There does not seem to be a simple relationship between contact radiation field on the bins and activity content as one would expect on the basis of a simple point source.

4.0 CONCLUSION AND RECOMMENDATIONS

Type I non processable waste is highly heterogenous. The characterization data show that some of this waste could, with some additional segregation effort at the source of generation be further processed.

Filters from the Freon based dry cleaning facility constitute a significant component of this waste stream (based on a relatively short sampling period) and should be easily processed by low force compaction. This should be confirmed using the existing compactor baler at BNPD. The suspected degree of Freon loading on the filter precludes at the present time the compaction option. This should be quantified because if it is significant it may be possible to recover most of the Freon and if these filters could be fabricated using only combustible materials, this waste could be incinerated along with the sludge generated in the dry cleaning operation.

Contaminated insulation from electrical cable could be stripped away to render a potentially recycleable non radioactive metal.

Lumber although a relatively small component of the waste could easily be incinerated provided it is not associated with non processable materials.

The economics of additional processing may be favorable in terms of reduced waste volumes and recovery and reuse of valuable materials. However, there will be additional dose committments as a result of this additional processing which may be in conflict with ALARA principles and thereby make this option impractical.

5.0 ACKNOWLEDGEMENT

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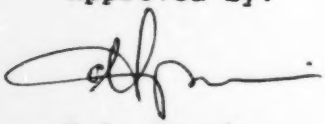

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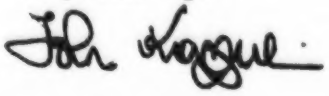

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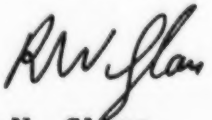

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9. F. McCullough, BNPD. Services, Private Communication.

TABLE 1

PERCENT COMPOSITION OF NON PROCESSABLE WASTE

% COMPOSITION	# OF BAGS								
	METAL	PLASTIC	PAPER	COTTON	RUBBER	NON-COMBUSTIBLE ABSORBENT	WOOD	GLASS	OTHER
0	527	856	707	976	977	748	1002	1095	1032
5	20	35	15	28	28	3	3	0	6
10	50	45	70	46	46	4	15	2	5
20	143	54	91	32	34	13	14	1	6
30	15	20	34	12	6	15	7	2	1
40	7	21	20	2	0	15	4	0	2
50	16	22	24	5	4	30	13	0	2
60	8	14	9	3	0	18	1	0	1
70	3	5	15	2	2	27	1	0	1
80	16	17	12	2	1	51	11	1	4
90	21	5	108	1	5	33	8	1	3
95	27	2	1	0	1	4	1	0	0
100	261	17	8	5	10	153	26	4	51
WEIGHTED MEAN	34	8	16	3	3	26	5	1	6

TABLE 2

RADIONUCLIDE COMPOSITION OF TYPE I NON-PROCESSABLE WASTE

BIN NO.	STORAGE DATE	WASTE DENSITY (kg/m3)	CONTACT FIELD MAX (mR/h)	CONTACT FIELD AVG (mR/h)	MAX. TOTAL ACTIVITY (mCi)	RADIONUCLIDE CONTRIBUTION(%) Cr51	Mn54	Co58	Fe59	Co60	Zr95	Nb95	Ru103	Ru106	Sb124	Sb125	I131	Cs134	Cs137	Ba140	La140	Ce141	Ce144
427	04/85	-	15	11	3.2	0%	0%	0%	0%	47%	8%	15%	6%	13%	0%	2%	0%	1%	4%	0%	2%	2%	1%
440	08/85	-	3	2.5	0.3	8%	0%	0%	0%	72%	2%	4%	0%	0%	0%	2%	0%	3%	8%	0%	0%	0%	0%
452	10/85	-	6	3	1.6	11%	0%	0%	0%	62%	0%	21%	0%	0%	0%	0%	0%	0%	4%	0%	0%	0%	2%
461	11/85	-	40	12	2.9	1%	1%	0%	0%	39%	12%	37%	0%	4%	0%	0%	0%	1%	5%	0%	0%	0%	0%
549	04/86	-	15	10	9.9	0%	0%	0%	1%	3%	16%	29%	12%	3%	0%	0%	1%	2%	15%	5%	6%	5%	2%
550	04/86	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
454	04/86	-	20	10	0.9	0%	0%	0%	0%	8%	0%	1%	0%	0%	0%	0%	0%	3%	89%	0%	0%	0%	0%
1126	06/87	166	5	3	2.2	8%	0%	0%	0%	41%	8%	15%	1%	5%	5%	1%	0%	2%	11%	0%	0%	0%	3%
1125	06/87	203	26	14	10.2	10%	1%	0%	1%	20%	23%	44%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
1277	07/87	238	17	10	3.6	0%	0%	0%	0%	29%	15%	24%	2%	2%	0%	2%	0%	1%	18%	0%	0%	3%	4%
1268	07/87	233	3	3	3.3	1%	0%	0%	0%	46%	2%	6%	0%	2%	0%	7%	0%	1%	33%	0%	0%	0%	1%
1346	08/87	230	1	1	0.1	3%	1%	0%	0%	72%	1%	0%	0%	0%	0%	0%	0%	3%	18%	0%	0%	0%	2%
1342	08/87	292	2	1	1.5	5%	1%	0%	0%	54%	2%	2%	0%	0%	0%	3%	0%	5%	26%	0%	0%	0%	2%
1388	08/87	337	1	1	0.4	0%	0%	0%	0%	56%	5%	5%	0%	0%	5%	0%	0%	3%	21%	0%	0%	0%	5%
1389	08/87	140	10	7	3.2	0%	0%	0%	0%	14%	5%	12%	0%	15%	1%	1%	0%	5%	24%	0%	0%	0%	24%
1415	09/87	261	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1416	09/87	180	2	2	0.6 (1.0)	0%	1%	0%	0%	17%	5%	12%	0%	15%	1%	1%	0%	4%	28%	0%	0%	0%	15%
1417	09/87	219	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1003	09/87	222	2	2	0.4 (0.01)	0%	1%	0%	0%	21%	3%	6%	0%	11%	0%	0%	0%	8%	42%	0%	0%	0%	8%
	AVERAGE	227				3%	0%	0%	0%	38%	7%	14%	1%	4%	1%	1%	0%	3%	22%	0%	1%	1%	4%